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(54) COLLISION ENERGY ABSORBING MEMBER AND COLLISION ENERGY ABSORPTION STRUCTURE USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To solve such a problem that a large energy absorptive characteristic can not be obtained because of a larger initial peak load and an large difference of average load.

SOLUTION: The collision energy absorption member has rigidity as much as 20% or lower of a hollow sectional columnar member used for a purpose absorbing collision energy, and a material having the average load of crushing as much as 50% or larger of the columnar member is charged in the columnar member, or in a member in which a material having a smaller rigidity than the columnar member is charged, a reinforcing rib or weld bead is fitted to a position corresponding to a node of the buckling mode of the columnar member under the axial compression action.



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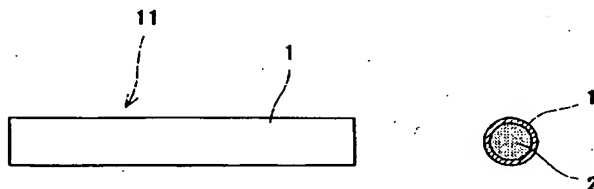
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(54) 【発明の名称】 衝突エネルギー吸収部材及びこれを用いた衝突エネルギー吸収構造

(57) 【要約】

【課題】 初期ピーク荷重が大きく平均荷重の差が大きいため、大きなエネルギー吸収特性が得られない。

【解決手段】 衝突エネルギーを吸収する目的で使用される中空断面の柱状部材の20%以下の軸剛性を有し、かつ、この柱状部材の50%以上の圧縮時の平均荷重を有する物質を柱状部材の内部に充填する。或いは柱状部材の内部に柱状部材より剛性の小さな物質を充填した部材において、軸圧縮力作用下での柱状部材の座屈モードの節に当たる位置に補強リブ又は溶接ビードを取り付ける。



【特許請求の範囲】

【請求項1】 衝突エネルギーを吸収する目的で使用される中空断面の柱状部材の20%以下の軸剛性を有し、かつ、この柱状部材の50%以上の圧壊時の平均荷重を有する物質を該柱状部材の内部に充填してなる衝突エネルギー吸収部材。

【請求項2】 中空断面の柱状部材の内部に該柱状部材より剛性の小さな物質を充填した部材において、軸圧縮力作用下での該柱状部材の座屈モードの節に当たる位置に補強リブを取り付けてなる衝突エネルギー吸収部材。

【請求項3】 中空断面の柱状部材の内部に該柱状部材より剛性の小さな物質を充填した部材において、軸圧縮力作用下での該柱状部材の座屈モードの節に当たる位置に溶接ビード盛りを取り付けてなる衝突エネルギー吸収部材。

【請求項4】 中空断面の柱状部材の内部に該柱状部材より剛性の小さな物質を充填した部材において、柱状部材の断面形状を長手方向の一部あるいは全部を波状に変化させてなる衝突エネルギー吸収部材。

【請求項5】 鉄道車両等の車端部の幅方向に請求項1～4いずれか1項に記載のエネルギー吸収部材を平行に列設してなる衝突エネルギー吸収構造。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は鉄道車両等の輸送機器における衝突時の衝突エネルギーを吸収する部材ないし構造に関する。

【0002】

【従来の技術】 従来より、中空断面の柱状部材を軸方向に蛇腹状に塑性変形させて衝突エネルギーを吸収するエネルギー吸収部材が知られている。

【0003】 例えば、特開昭58-116267号公報に記載の自動車の車体フレーム構造では、軸方向に切り欠き部を設けたチャンネル部材と切り欠き部のないチャンネル部材とを組み合わせた箱型断面構造によって、長手方向に衝撃力により蛇腹変形を生じさせ、変形現象が異なる切り欠き部に対応した部位で順次生じさせて、図8(b)のようなエネルギー吸収曲線図を得て衝突エネルギーの吸収能力を高めんとする。

【0004】 この従来技術は、図8(a)に示すような箱型断面柱01において、座屈が起きた瞬間の最初のピーク荷重P1は、図8(b)に示すように高いままで、他にも幾つかピーク荷重P2、P3、・・・を生じるような部材構成にしてエネルギー吸収能力を高めんとする思想である。なお、図8(a)は、箱型断面柱01における変形領域(斜線で示す)の遷移を模式的に示したもので、図8(b)は、これに対応する圧壊荷重(縦軸)と変位(横軸)の関係図である。

【0005】

【発明が解決しようとする課題】 理想的な衝突エネルギー

一吸収構造は、必要な静的強度を確保しつつ、衝突時に大きな加速度を生じることなく、かつ、エネルギー吸収量の大きい構造である。エネルギー吸収構造の圧壊時の荷重と変位の関係において、ピーク荷重、特に初期ピーク荷重が大きいと、衝突時に生じる加速度の最大値は大きくなり、平均圧壊荷重が大きいとエネルギー吸収量は大きくなる。したがって、初期ピーク荷重が小さく、かつ平均圧壊荷重が大きい構造が優れたエネルギー吸収構造である。

【0006】 また、中空断面の柱状部材を用いたエネルギー吸収構造では、規則正しく長手方向に蛇腹変形を生じさせることが大きなエネルギー吸収量を得ることになる。

【0007】 しかし、上記従来のエネルギー吸収部材では、図8(b)に示すように初期ピーク荷重と平均荷重の差が大きいため、十分大きなエネルギー吸収量を得ようとすると、初期ピーク荷重が必要以上に高くなる。

【0008】 また、上記従来のエネルギー吸収部材では、規則正しく長手方向に蛇腹変形を起こさせるために部材に切り欠きを設けている。しかし、この方法では、部材本来の強度を低下させるために、軽微な衝突に対しても部材が塑性変形する可能性がある。

【0009】 特開2000-142461号では、発砲ウレタン樹脂を充填した金属強度部材とエネルギー吸収部材との複合材料からなる衝撃吸収用構造部材が提案されているが、これには平均圧壊荷重を高める思想はないため、エネルギー吸収能は小さい。

【0010】 そこで、本願発明の目的は、衝突エネルギーを吸収する部材において、静的強度を低下させることなく衝突時の平均圧壊荷重を高めて、さらに長手方向に規則正しく蛇腹変形を起こさせて、衝突エネルギー吸収能力を高めるエネルギー吸収部材ないし構造を提供することにある。

【0011】

【課題を解決するための手段】 上記課題を解決するため、本願発明は、衝突エネルギーを吸収する目的で使用される中空断面の柱状部材の20%以下の軸剛性を有し、かつ、この柱状部材の50%以上の圧壊時の平均荷重を有する物質を該柱状部材の内部に充填してなるエネルギー吸収部材である。

【0012】 これにより、この衝突エネルギー吸収部材の荷重-変位の関係は最大荷重と圧壊時の平均荷重の差が小さい優れたエネルギー吸収部材となる。

【0013】 すなわち、上記のように柱状部材の20%以下の軸剛性を有し、かつ、この柱状部材の50%以上の圧壊時の平均荷重を有する物質(以下「充填材料」ともいう)を充填した柱状部材では、柱状部材が初期ピーク荷重になるときに充填材料は弾性域にとどまるため、初期ピーク荷重は柱状部材単体の場合に比較して大きく増加しない。一方、柱状部材の圧壊変形が進んだ状態で

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は、充填材料も大きな変形を受けるため、その崩壊強度まで荷重を支え、圧壊強度の向上に寄与することになる。すなわち、柱状部材単体では初期ピーク荷重が平均圧壊荷重に比較して大きい、充填材料は柱状部材の50%以上の圧壊時の平均荷重を有することから、初期ピーク荷重と平均圧壊荷重の差が小さくなり、優れたエネルギー吸収特性を有することになる。

【0014】また、中空断面の柱状部材の内部に柱状部材より剛性の小さな物質を充填し、かつ軸方向に適切な間隔で補強リブ、または、溶接ビード盛りを軸圧縮力作用下での中空断面の柱状部材の座屈モードの節に当たる位置に取り付ける。これにより、柱状部材の圧壊モードが拘束され、長手方向に規則正しく蛇腹変形を起こさせることが可能となる。

【0015】また、中空断面の柱状部材の内部に柱状部材より剛性の小さな物質を充填し、かつ、柱状部材の断面形状を長手方向の一部あるいは全部を波状に変化させることにより、柱状部材の圧壊モードが拘束され、長手方向に規則正しく蛇腹変形を起こさせることが可能となる。

【0016】また、上記のエネルギー吸収部材を鉄道車両等の車端部の幅方向に平行に列設すれば、衝突時のエネルギー吸収特性の優れたエネルギー吸収構造が得られる。

【0017】

【発明の実施の形態】本願発明の鉄道車両等用の衝突エネルギー吸収部材の概念は、前述したように圧壊時の初期ピーク荷重の増加を押さえつつ平均荷重を増加させ、また長手方向に規則正しく蛇腹変形を起こさせることにある。以下、そのための実施形態を図面を参照しながら説明する。

【0018】【第一実施形態】図1(a)(b)は、本願発明のエネルギー吸収部材11の一形態の正面図と断面図で、この図に示したものは、中空断面の柱状部材である管部材1の内部に、管部材1の20%以下の軸剛性を有し、かつ、この管部材の50%以上の圧壊時の平均荷重を有する物質(充填材料)2を充填したエネルギー吸収部材11である。

【0019】例えば、管部材を円管とし、断面寸法を外径165mm、板厚5.5mmでヤング率206000MPaの軟鋼で製作し、ヤング率約400MPa、圧縮強度4.0MPaのウレタン発泡材で充填することにより本エネルギー吸収部材11を実現できる。

【0020】上記充填材料(例えば、ウレタン発泡材)の特性としては、その軸剛性を管部材の軸剛性の20%以下とすれば、この衝突エネルギー吸収部材の最大荷重は、管部材のみのエネルギー吸収部材の最大荷重と比較して、最大荷重の増加は20%以下となる。これは、管部材が最大荷重に達するまでの荷重分担は両者の軸剛性に比例するためである。

【0021】また、充填材料の圧壊強度を管部材の圧壊時の平均荷重の50%以上とすれば、本衝突エネルギー吸収部材の圧壊時の平均荷重は1.5倍以上となる。仮に、充填材料の圧壊強度を、管部材の最大強度と圧壊時の平均強度の差とすれば、本エネルギー吸収部材の最大荷重と圧壊時の平均荷重の差はなくなる。このように、充填材料の圧壊荷重を管部材の圧壊荷重の50%以上としていれば、本エネルギー吸収部材の圧壊時の平均荷重の増加に効果がある。

【0022】これは図5によっても説明できる。図1に示したエネルギー吸収部材11では、軸方向に圧縮荷重が作用したときの荷重(縦軸)と変位(横軸)の関係は図5のようになる。図5は硬質発泡ウレタン充填鋼管の静的圧壊試験により得られた結果である。管部材単体および充填材単体の荷重と変位の関係はそれぞれ図中の一点鎖線および点線となり、本発明のエネルギー吸収部材では実線のようになる。すなわち、合成果により中空断面の管部材と充填材との合計である点線より少し高目の荷重となる。したがって、本エネルギー吸収部材11では、管部材単体の荷重と変位の関係に比較して、初期ピーク荷重の増加は小さく、平均圧縮荷重の増加は大きくなる。

【0023】このように充填材料の軸剛性と圧壊強度を管部材との関係において適切に選べば、最大荷重と圧壊時の平均反力の差が小さい構造とすることが可能である。

【0024】【第二実施形態】図2に示したものは、内部に発泡材2を充填した中空断面の柱状部材1において、軸圧縮力作用下での中空断面の柱状部材1の座屈モードの節に当たる位置(節に当たる柱状部材1の外周囲)に補強リブ3を取り付けたエネルギー吸収部材11である。図2(a)はその正面図、(b)は断面図である。柱状部材1に軸圧縮力をかけると、座屈時に節となるべき位置が補強リブで補強されているため、補強リブ3の位置が必ず節となり、例えば円形断面の場合は隣合う補強リブの間が図6のように半径方向に膨出する形(蛇腹変形)で崩壊する。

【0025】これにより、柱状部材の圧壊モードが拘束され、図6の如く長手方向に規則正しく蛇腹変形を起こさせることが可能となる。その結果として所望のエネルギー吸収特性が発揮されることになる。

【0026】【第三実施形態】図3に示したものは、内部に発泡材2を充填した中空断面の柱状部材1において、軸圧縮力作用下での中空断面の柱状部材1の座屈モードの節に当たる位置(節に当たる柱状部材1の外周囲)に溶接ビード4を取り付けたエネルギー吸収部材11である。図3(a)はその正面図、(b)は断面図である。この場合も前述の第二実施形態と同様に、溶接ビード4によって節となるべき位置が補強されているため、座屈時に溶接ビード4の位置が必ず節となり、例え

ば円形断面の場合は隣合う溶接ビード4の間が図6のように半径方向に膨出する形(蛇腹変形)で崩壊する。

【0027】これにより、柱状部材の圧壊モードが拘束され、図6の如く長手方向に規則正しく蛇腹変形を起こさせることが可能となる。その結果として所望のエネルギー吸収特性が発揮されることになる。

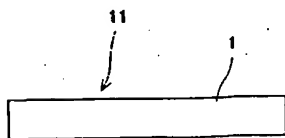
【0028】〔第四実施形態〕図4に示したものは、内部に発泡材2を充填した中空断面の柱状部材1において、柱状部材1の長手方向の一部あるいは全部を波状に変化させたエネルギー吸収部材11である。これにより、軸荷重を作用させて柱状部材1を座屈させた時には波状の谷部5が節となり山部6が膨出するから、上記と同様に、柱状部材1の圧壊モードが拘束され、長手方向に規則正しく蛇腹変形を起こさせることが可能となる。

【0029】図7は、上記いずれかのエネルギー吸収部材11を用いて、これを鉄道車両の車端部に使用してエネルギー吸収構造を構成した例である。車端部の前後に設けた仕切板7、8の間に本エネルギー吸収部材1を架設する。つまり、複数のエネルギー吸収部材1を車体の幅方向に平行に列設する。衝突時の衝撃力の方向と一致するよう、エネルギー吸収部材1はいずれもその長手方向を車体の前後方向に一致させて配設してある。これにより、衝突時のエネルギー吸収性能の優れた構造が得られる。なお、後部の仕切板の後方にはセンターシル9、さらにこの後方にはボルスター10が配置されて車端部の構体が形成されている。

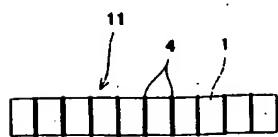
【0030】

【発明の効果】上記本願発明によれば、圧壊時の初期ピーク荷重の増加を押さえつつ平均圧壊荷重を増加させることができる結果、初期ピーク荷重と平均圧壊荷重の差が小さくなり、優れたエネルギー吸収特性を有する衝突エネルギー吸収部材を得ることができる。

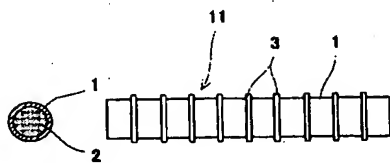
【図1】



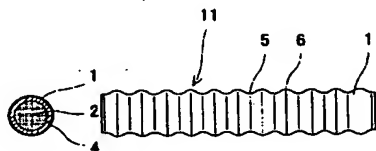
【図3】



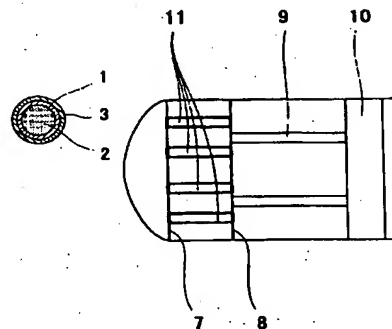
【図2】



【図4】



【図7】



【0031】また、柱状部材の座屈モードの節に当たる位置を補強する等により、柱状部材の圧壊モードが拘束され、長手方向に規則正しく蛇腹変形を起こさせることが可能となる結果、所望のエネルギー吸収特性を発揮する衝突エネルギー吸収部材を得ることができる。

【図面の簡単な説明】

【図1】(a) (b)は、本願第一実施形態に係る衝突エネルギー吸収部材の平面図と断面図である。

【図2】(a) (b)は、本願第二実施形態に係る衝突エネルギー吸収部材の平面図と断面図である。

【図3】(a) (b)は、本願第三実施形態に係る衝突エネルギー吸収部材の平面図と断面図である。

【図4】(a) (b)は、本願第四実施形態に係る衝突エネルギー吸収部材の平面図と断面図である。

【図5】図1に示したエネルギー吸収部材の軸方向に圧縮荷重が作用したときの荷重(縦軸)と変位(横軸)の関係図である。

【図6】柱状部材が蛇腹変形を起こした状態の図である。

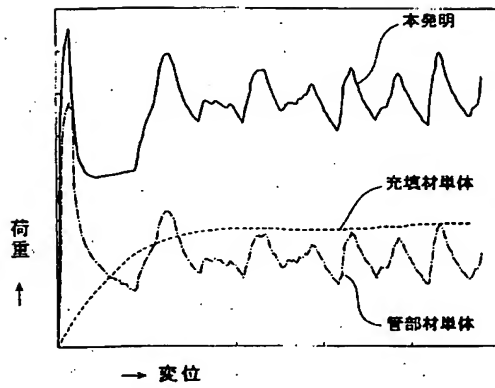
【図7】本願の衝突エネルギー吸収部材を用いて車端部の構体を形成したときの平面図である。

【図8】従来技術の説明図であって、(a)は箱型断面の柱状部材の変形領域(斜線部)の遷移を模式的に示す斜視図、(b)はこれを軸方向に圧壊させたときの荷重と変位の関係である。

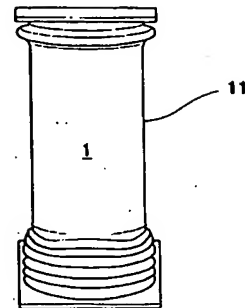
【符号の説明】

- 1 管部材(柱状部材)
- 2 充填材料(発泡材)
- 3 補強リブ
- 4 溶接ビード
- 11 (衝突)エネルギー吸収部材

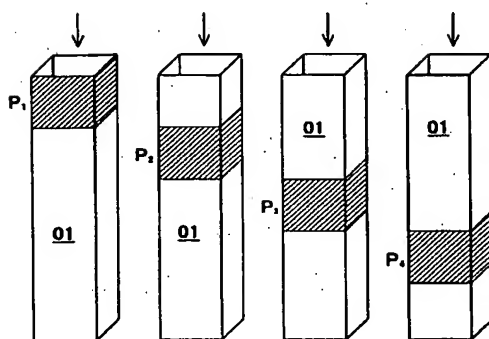
【図5】



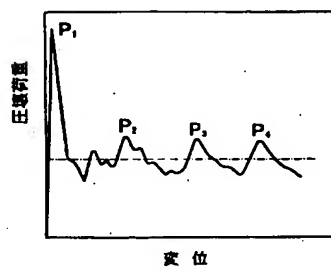
【図6】



【図8】



(a)



(b)

フロントページの続き

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Fターム(参考) 3J066 AA23 BA03 BB01 BC01 BE06
BF04 BG04

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CLAIMS

[Claim(s)]

[Claim 1] A collision energy-absorbing member which comes to fill [the interior of this pillar-shaped member] up matter which has 20% or less of axial rigidity of a pillar-shaped member of a hollow cross section used in order to absorb collision energy, and has an average load at the time of 50% or more of crushing of this pillar-shaped member.

[Claim 2] A collision energy-absorbing member which comes to attach a reinforcing rib in a location which hits a knot of buckling mode of this pillar-shaped member under an axial compressive-force operation in a member filled up with rigid small matter from this pillar-shaped member inside a pillar-shaped member of a hollow cross section.

[Claim 3] A collision energy-absorbing member which comes to attach the weld bead peak in a location which hits a knot of buckling mode of this pillar-shaped member under an axial compressive-force operation in a member filled up with rigid small matter from this pillar-shaped member inside a pillar-shaped member of a hollow cross section.

[Claim 4] A collision energy-absorbing member to which a part or all of a longitudinal direction is made to come for a cross-section configuration of a pillar-shaped member to change in the shape of a wave in a member which filled up the interior of a pillar-shaped member of a hollow cross section with rigid small matter from this pillar-shaped member.

[Claim 5] Collision energy-absorbing structure which comes to install successively a energy-absorbing member given [the cross direction of vehicle edges, such as a rail car,] in claim 1 - 4 any 1 terms to parallel.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to the member thru/or structure which absorbs the collision energy at the time of the collision in transport-airplane machines, such as a rail car.

[0002]

[Description of the Prior Art] The energy-absorbing member which the shape of bellows is made to carry out plastic deformation of the pillar-shaped member of a hollow cross section to shaft orientations, and absorbs collision energy conventionally is known.

[0003] For example, in the body frame structure of an automobile given in JP,58-116267,A, according to the core box cross-section structure which combined with shaft orientations the channel member which prepared the notching section, and the channel member without the notching section, make a longitudinal direction produce bellows deformation according to impulse force, it is made to be generated one by one by the part corresponding to the notching section from which metaboly differs, and energy-absorbing curvilinear drawing like drawing 8 (b) is obtained, and let absorptance of collision energy be high noodles.

[0004] In the core box cross-section pillar 01 as shows this conventional technology to drawing 8 (a), the peak load P1 of the beginning of the flash when the buckling occurred is thought which makes it a member configuration which produces some the PI 1 KU loads P2 and P3 and ... also in others, and makes energy absorbing capacity high noodles until now [high], as shown in drawing 8 (b). In addition, drawing 8 (a) is what showed typically transition of the deformation field (a slash shows) in the core box cross-section pillar 01, and drawing 8 (b) is related drawing of a crushing load (axis of ordinate) and a variation rate (horizontal axis) corresponding to this.

[0005]

[Problem(s) to be Solved by the Invention] Ideal collision energy-absorbing structure is the structure where the amount of energy-absorbing is large, without producing big acceleration at the time of a collision, securing required static reinforcement. In the load at the time of crushing of energy-absorbing structure, and the relation of a variation rate, the maximum of the acceleration which will be produced at the time of a collision if a peak load, especially an initial peak load are large becomes large, and if an average crushing load is large, the amount of energy-absorbing will become large. Therefore, an initial peak load is the energy-absorbing structure in which the structure where an average crushing load is large was excellent small.

[0006] Moreover, with the energy-absorbing structure using the pillar-shaped member of a hollow cross section, the amount of energy-absorbing with big making a longitudinal direction produce bellows deformation regularly will be obtained.

[0007] However, in the above-mentioned conventional energy-absorbing member, if it is going to obtain the sufficiently big amount of energy-absorbing since the difference of an initial peak load and an average load is large as shown in drawing 8 (b), an initial peak load will become high beyond the need.

[0008] Moreover, in the above-mentioned conventional energy-absorbing member, in order to make a longitudinal direction cause bellows deformation regularly, notching is prepared in the member. However, by this method, in order to reduce the reinforcement of member original, a member may deform plastically also to a slight collision.

[0009] Although the structural member for impact absorptions which consists of composite material of the metal load member and energy absorption member which were filled up with firing urethane resin is proposed in JP,2000-142461,A, since there is no thought which raises an average crushing load in this, energy-absorbing ability is small.

[0010] Then, in the member which absorbs collision energy, the object of the invention in this application raises the average crushing load at the time of a collision, without reducing static reinforcement, and is further to offer the energy-absorbing member thru/or structure which is made to cause bellows deformation regularly to a longitudinal direction, and heightens collision energy absorbing capacity.

[0011]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the invention in this application is a energy-absorbing member which comes to fill [the interior of this pillar-shaped member] up matter which has 20% or less of axial rigidity of a pillar-shaped member of a hollow cross section used in order to absorb collision energy, and has an average load at the time of 50% or more of crushing of this pillar-shaped member.

[0012] Thereby, it is the load of this collision energy-absorbing member. - Relation of a variation rate serves as an outstanding energy-absorbing member with a small difference of maximum load and an average load at the time of crushing.

[0013] That is, in a pillar-shaped member filled up with matter (henceforth a "packing material") which has 20% or less of axial rigidity of a pillar-shaped member as mentioned above, and has an average load at the time of 50% or more of crushing of this pillar-shaped member, since a packing material remains in an elastic region when a pillar-shaped member becomes an initial peak load, an initial peak load does not increase greatly as compared with a case of a pillar-shaped member simple substance. On the other hand, after crushing deformation of a pillar-shaped member has progressed, in order that a packing material may also receive big deformation, a load will be supported to the breaking reinforcement and it will contribute to improvement in crushing reinforcement. That is, in a pillar-shaped member simple substance, although an initial peak load is large as compared with an average crushing load, since a packing material has an average load at the time of 50% or more of crushing of a pillar-shaped member, a difference of an initial peak load and an average crushing load becomes small, and it will have an outstanding energy absorption property.

[0014] Moreover, the interior of a pillar-shaped member of a hollow cross section is filled up with rigid small matter from a pillar-shaped member, and a reinforcing rib or the weld bead peak is attached in a location equivalent to a knot of buckling mode of a pillar-shaped member of a hollow cross section under an axial compressive-force operation at a suitable gap for shaft orientations. Thereby, crushing mode of a pillar-shaped member is restrained and it becomes possible to make a longitudinal direction cause bellows deformation regularly.

[0015] Moreover, by filling up the interior of a pillar-shaped member of a hollow cross section with rigid small matter from a pillar-shaped member, crushing mode of a pillar-shaped member is restrained in a cross-section configuration of a pillar-shaped member by changing a part or all of a longitudinal direction in the shape of a wave, and it becomes possible to make a longitudinal direction cause bellows deformation regularly.

[0016] Moreover, if the above-mentioned energy-absorbing members are installed successively to parallel crosswise [of vehicle edges, such as a rail car,], energy-absorbing structure which was excellent in a energy-absorbing property at the time of a collision will be acquired.

[0017]

[Embodiment of the Invention] The concept of the collision energy-absorbing member of business, such as a rail car of the invention in this application, is in making an average load increase, pressing down the

increment in the initial peak load at the time of crushing, as mentioned above, and making a longitudinal direction cause bellows deformation regularly. Hereafter, the operation gestalt for it is explained, referring to a drawing.

[0018] [First operation gestalt] drawing 1 (a) and (b) are the front view and the cross sections of one gestalt of the invention in this application, and what was shown in this drawing is the energy-absorbing member 11 filled up with the matter (packing material) 2 which has 20% or less of axial rigidity of the pipe member 1 inside the pipe member 1 which is a pillar-shaped member of a hollow cross section, and has an average load at the time of 50% or more of crushing of this pipe member inside. [of the energy-absorbing member 11]

[0019] For example, a pipe member is used as a tube, a cross-section size is manufactured with the mild steel of Young's modulus 206000MPa by the outer diameter of 165mm, and 5.5mm of board thickness, and this energy-absorbing member 11 can be realized by filling up with the urethane foam of Young's modulus about 400 MPa(s), and compressive strength 4.0MPa.

[0020] In the maximum load of the 20% or less, then this collision energy-absorbing member of axial rigidity of a pipe member, as a property of the above-mentioned packing material (for example, urethane foam), the increment in maximum load becomes 20% or less about that axial rigidity as compared with the maximum load of the energy-absorbing member of only a pipe member. A load assignment until, as for this, a pipe member reaches maximum load is because it is proportional to both axial rigidity.

[0021] Moreover, the average load at the time of crushing of the 50% or more, then this collision energy-absorbing member of the average load at the time of crushing of a pipe member becomes 1.5 or more times about the crushing reinforcement of a packing material. Temporarily, the difference of the maximum reinforcement of a pipe member and the average reinforcement at the time of crushing, then the difference of the maximum load of this energy-absorbing member and the average load at the time of crushing are lost in the crushing reinforcement of a packing material. Thus, if the crushing load of a packing material is made into 50% or more of the crushing load of a pipe member, an effect is in the increment in the average load at the time of crushing of this energy-absorbing member.

[0022] Drawing 5 can also explain this. In the energy-absorbing member 11 shown in drawing 1, a load (axis of ordinate) when a compressive load acts on shaft orientations, and the relation of a variation rate (horizontal axis) become like drawing 5. Drawing 5 is the result of being obtained by the static crushing trial of a hard urethane foam restoration steel pipe. The load of a pipe member simple substance and a filler simple substance and the relation of a variation rate serve as an alternate long and short dash line in drawing, and a dotted line, respectively, and become like a continuous line in the energy-absorbing member of this invention. That is, it becomes the load of eye the high one from the dotted line which is the sum total of the pipe member of a hollow cross section, and a filler for a while according to a synthetic effect. Therefore, in this energy-absorbing member 11, as compared with the load of a pipe member simple substance, and the relation of a variation rate, the increment in an initial peak load is small, and the increment in an average compressive load becomes large.

[0023] Thus, if the axial rigidity of a packing material and crushing reinforcement are appropriately chosen in relation with a pipe member, the difference of maximum load and the average reaction force at the time of crushing is able to consider as small structure.

[0024] What was shown in [second operation gestalt] drawing 2 is the energy-absorbing member 11 which attached the reinforcing rib 3 in the location (periphery enclosure of the pillar-shaped member 1 which hits a knot) equivalent to the knot of the buckling mode of the pillar-shaped member 1 of the hollow cross section under an axial compressive-force operation in the pillar-shaped member 1 of the hollow cross section which filled up the interior with foam 2. Drawing 2 (a) is the front view, and (b) is a cross section. If axial compressive force is applied to the pillar-shaped member 1, since the location which should serve as a knot at the time of buckling is reinforced with the reinforcing rib, the location of a reinforcing rib 3 surely serves as a knot, for example, in the case of a circular cross section, it collapses in the form (bellows deformation) where between ***** reinforcing ribs bulges radially like drawing 6.

[0025] Thereby, the crushing mode of a pillar-shaped member is restrained and it becomes possible like

drawing 6 to make a longitudinal direction cause bellows deformation regularly. A desired energy-absorbing property will be demonstrated as the result.

[0026] What was shown in [third operation gestalt] drawing 3 is the energy-absorbing member 11 which attached the weld bead 4 in the location (periphery enclosure of the pillar-shaped member 1 which hits a knot) equivalent to the knot of the buckling mode of the pillar-shaped member 1 of the hollow cross section under an axial compressive-force operation in the pillar-shaped member 1 of the hollow cross section which filled up the interior with foam 2. Drawing 3 (a) is the front view, and (b) is a cross section. Since the location which should serve as a knot by the weld bead 4 like the above-mentioned second operation gestalt is reinforced also in this case, the location of a weld bead 4 surely serves as a knot at the time of buckling, for example, in the case of a circular cross section, it collapses in the form (bellows deformation) where between the ***** weld beads 4 bulges radially like drawing 6.

[0027] Thereby, the crushing mode of a pillar-shaped member is restrained and it becomes possible like drawing 6 to make a longitudinal direction cause bellows deformation regularly. A desired energy-absorbing property will be demonstrated as the result.

[0028] What was shown in [fourth operation gestalt] drawing 4 is the energy-absorbing member 11 to which a part or all of a longitudinal direction of the pillar-shaped member 1 was changed in the shape of a wave in the pillar-shaped member 1 of the hollow cross section which filled up the interior with foam 2. Since the wave-like trough 5 serves as a knot and Yamabe 6 bulges when axial load is made to act and the pillar-shaped member 1 is made to buckle by this, like the above, the crushing mode of the pillar-shaped member 1 is restrained, and it becomes possible to make a longitudinal direction cause bellows deformation regularly.

[0029] Drawing 7 is the example which constituted energy-absorbing structure at the vehicle edge of a rail car using this using the energy-absorbing member 11 of one of the above. This energy-absorbing member 1 is constructed among the dashboards 7 and 8 formed before and behind the vehicle edge. That is, two or more energy-absorbing members 1 are installed successively to parallel crosswise [of the body]. The energy-absorbing member 1 makes the longitudinal direction of all correspond with the cross direction of the body, and is arranged so that it may be in agreement with the direction of the impulse force at the time of a collision. Thereby, the structure which was excellent in the energy-absorbing engine performance at the time of a collision is acquired. In addition, behind a hind dashboard, a bolster 10 is arranged at a center sill 9 and a pan at this back, and the structure of a vehicle edge is formed.

[0030]

[Effect of the Invention] As a result of being able to make an average crushing load increase according to the above-mentioned invention in this application, pressing down the increment in the initial peak load at the time of crushing, the collision energy-absorbing member which the difference of an initial peak load and an average crushing load becomes small, and has the outstanding energy absorption property can be obtained.

[0031] Moreover, the crushing mode of a pillar-shaped member is restrained by reinforcing the location equivalent to the knot of the buckling mode of a pillar-shaped member etc., and as a result of it becoming possible to make a longitudinal direction's cause bellows deformation regularly, the collision energy-absorbing member which demonstrates a desired energy-absorbing property can be obtained.

[Translation done.]

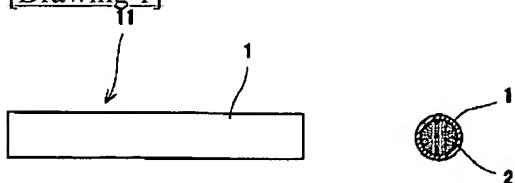
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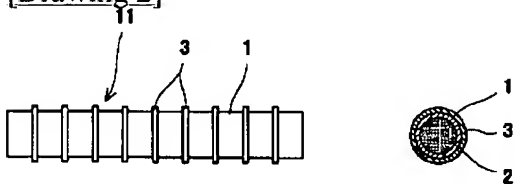
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DRAWINGS

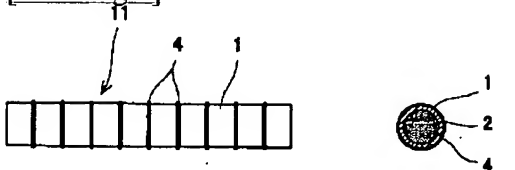
[Drawing 1]



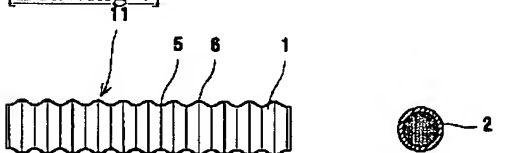
[Drawing 2]



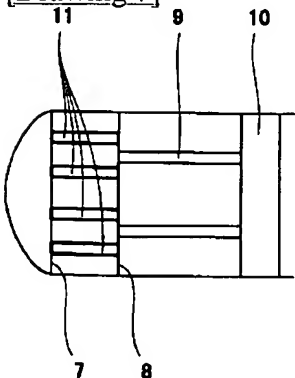
[Drawing 3]



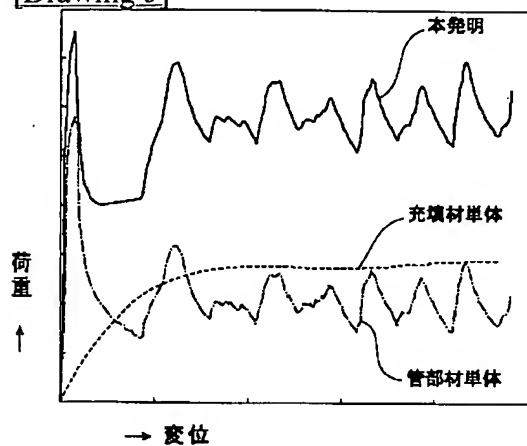
[Drawing 4]



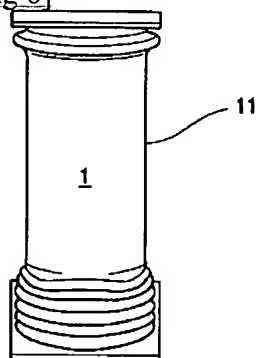
[Drawing 7]



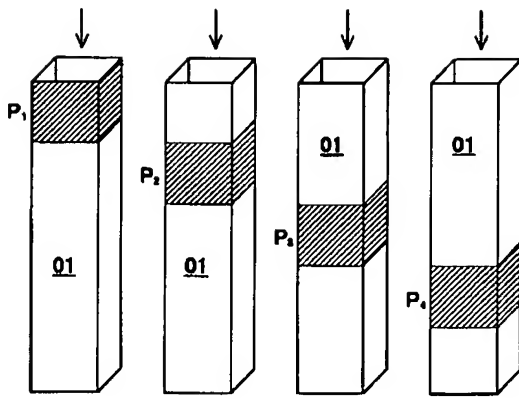
[Drawing 5]



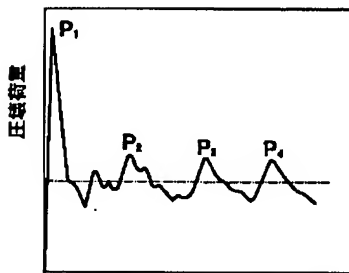
[Drawing 6]



[Drawing 8]



(a)



(b)

[Translation done.]